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User Environment Definition for the ECS Project

White Paper

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Abstract

The User Environment Definition is a working white paper addressing the cost of hardware and software necessary for an end user to access ECS data and services. The white paper identifies and discusses the six (6) System Access Classes identified by the ECS User/Data Model. The reference configurations and costing are provided based on the System Access Class requirements. Several of the reference configurations support complete access to all ECS data and services, while other reference configurations support the requirements of users with less demanding access requirements. An overview of the available and emerging technologies that may be used for general information and registration access by the general public to ECS is also provided.

Reference configurations are provided to identify the hardware and software that will be needed from commercial and public domain sources, as well as the software and facilities that will be provided by ECS. Costing tables are provided for all reference configurations for the years 1994, 1996, 1998 and 2000.

Key Words:

Traditional

Consumer

Browser

Analytical

Production

Machine-to-Machine

Hardware

Software

Costs

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Contents

1. Introduction

2. User Characteristics

3. Reference Platforms

Tables

Figures

Abbreviations and Acronyms

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1. Introduction

As part of the User/Data Modeling process, ECS is working to identify the hardware and software components that will be needed to provide access to the ECS system for all levels and types of users. The system access envisioned includes capabilities to perform any user activity identified within the ECS User/Data Model. Just as the User/Data Model and other applicable specifications will be continually refined, the system access classifications will be refined as appropriate to reflect any changes in the system access classes. The software and hardware elements supporting user system access will continue to be monitored for technical evolution.

The ECS User/Data Model and the System Design seek to support as many of the concepts detailed in the GCDIS/UserDIS Study as is practical.

1.1 Background

The ECS User/Data Model seeks to characterize the potential users and the potential uses of ECS. An extensive array of user characteristics and potential uses of the ECS has been identified in the User/Data Model. These potential characteristics and uses include:

- User Data Access activities including Reviews, Theoretical Studies, Case Studies, Field Studies, and Climatological Studies.
- Discipline or interest areas, including Atmosphere, Climatology, Hydrology, Land Processes, Oceans, Sea Ice, Snow and Ice, Instrument, Interdisciplinary, Education, Federal Agencies, Policy Makers, and Commercial Users.
- Types of research activities including, Local/Case/Field studies, Regional Studies, Global Studies, and Instrument/Calibration Studies.
- Access to User Services, including Help/Consultation, Status, Account Management, and Interface services.

1.2 Scope

This document will present the system access groups or classes identified in the ECS User/Data Model. The user characteristics, reference platform and cost of each System Access Class will also be detailed in this document. This information will provide a reference for users considering participation in the ECS Project concerning the hardware/software required and the estimated associated cost of this reference platform for their participation levels. The study focuses primarily on the users who will be directly accessing ECS services and data, that is, users who register with ECS, obtain toolkits, etc. A brief overview of informational access and registration access to ECS by the general public is also provided.

1.3 Approach

The ECS User/Data Model White Paper[1] has identified a significant number of user classes from characteristics and uses identified in the full report. From this set of user classes, six (6) system access patterns or classes are currently identified[2]. These System Access Classes represent the system access requirements of all the user classes identified in the ECS User/Data Model.

The six System Access Classes will be identified and discussed in detail in this document. A reference configuration (software and/or hardware) will be included with the estimated costs for this reference configuration for the years 1994, 1996, 1998 and 2000.

1.4 Organization

Section 2 will identify and provide an overview of the System Access Classes, as presented at SDR. This will include a presentation of the user characteristics of each System Access Class, including:

- User Access to the ECS environment for user activities, including:
  - Query
  - Ordering
  - Status
  - Browsing
  - Processing
  - Transfer of data
- Transfer/Storage Media
- Data Format Types
- Volume of Data
- Frequency/Duration of Access
- Product Type (Standard or Customized)
- Tool Sets

Section 3 will present a reference platform for each System Access Class identified in section 2. The reference platform may include:

- Hardware
- COTS Software
- ECS-provided software/toolkits

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1 ECS User/Data Model: Approach and Plan White Paper, Working Draft, 11/12/93.

2 User Scenario Notebook, Working Draft 6/94 (192-003-11TPW).

- Public Domain Software

1.5 Review and Approval

This White Paper is an informal document approved at the Office Manager level. It does not require formal Government review or approval; however, it is submitted with the intent that review and comments will be forthcoming.

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2. User Characteristics

The ECS User/Data Model is concerned with highly granular user characteristics, including the user's discipline, i.e., Atmosphere, Climatology, Hydrology, Land Processes, Oceans, Sea Ice, Snow and Ice, as well as the interdisciplinary characteristics of ECS users. The System Access Classes focus on less granular areas. The System Access Classes generally are concerned with:

- The preferred method of access
- The types of access activities the user needs to engage in:
  - Query, Ordering, Status, Specifying Processing, etc., vs. Browsing, Network Transfer of Data Sets, etc.
- Frequency/Duration/Volume of Activity.
- Data Format and Toolkits required to support identified user characteristics.

At the level of system access, the ECS User/Data Model classes share many consistencies across various disciplines, study and research types. ECS will focus on the levels of access required and consider standards; user/technological evolution, including the characteristics outlined in the GCDIS/UserDIS Study[3]. User classes will evolve in respect to their basic technologies, just as ECS technologies will evolve.

2.1 Processes and Methodologies

Six (6) System Access Pattern Classes have been identified by the ECS User Modeling Group. These System Access Classes have been identified from completed and on-going User Model studies[4].

The User Characteristics relevant for a System Access Class include at least some of the following:

- User Access to the ECS Environment, including:
  - Terminal/Modem for computerless or low-end computer access
  - Internet SLIP/PPP for non-networked computer-to-computer access
  - Ethernet for networked computer-to-computer access
  - FDDI and other high-speed access technologies for high-speed computer-to-computer access.

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3 GCDIS/UserDIS Study, Draft 0.2, January 6, 1994.

4 ECS User/Data Model: Approach and Plan White Paper, Working Draft, 11/12/93 and User Scenario Notebook, Working Draft 6/94 (192-003-11TPW).

- Computing Device Characteristics, including:
  - System response time
  - Communication band width
  - Volume duration / level estimates
  - CPU processing capabilities/SPECmarks
  - I/O bandwidth.
- Transfer/Storage Media.
- Data Format types, including textual, numerical and graphical data.
- Volume of Data, which includes volume of data processed within ECS and volumes of data transferred (to user's local disk).
- Toolkits, which may include Compilers, DCE Client Services, Browsers or Visualization Tools, etc.

2.2 Access to ECS

This study focuses principally on the users that register with ECS and access ECS services and data in this registered user context[5]. Registered users will have complete access to all ECS services, toolkits, data, etc.

It should be noted that information access to ECS is also provided to the general public who are able to access WAIS/WWW (World Wide Web/Wide Area Information Search) Internet information servers. This initial access level will support the following functions:

- Capability to gain general information on ECS. This general information service, provided as a human readable version of the ECS Advertising Service, will be available to all users, registered or unregistered. Registration with ECS is not required for initial or continued access to this general ECS information source.
- Capability to obtain information on the data and services that are available to registered ECS users.
- Capability to become a registered ECS user with full access to ECS data and services.

The reference configuration for this initial access (to register with ECS) or general information access will consist of widely available Internet access connections and Internet access tools. Network connections to the Internet are available at many commercial and most higher-level educational institutions. Many governmental organizations are either providing Internet access to their users or working on plans to provide Internet access. There is also a wide array of Internet access providers and an increasing number of public domain and commercial software products supporting Internet information access mechanisms, such as WWW and WAIS. The

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5 Registered Users are discussed in section 4.5.1.3 Client Subsystem Description in the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001).

WWW-based Mosaic, commonly utilizing HTTP/HTML [6], is one of the most prominent of these tools. An overview of the availability of Internet access and tools is provided in section 2.3.1.3, Common Communications Characteristics, in this document. As indicated in this section, Internet access providers and Internet tools are available on a wide variety of platforms and from a variety of providers to suit virtually any user environment.

While general information and registration access to ECS are supported by the majority of these generally available Internet access methods and tools, it should however be noted that not all Internet access providers, Internet tools and computing platforms will be suited for all types of ECS access, query and toolkit usage by registered ECS users. Section 2.4.3.1 specifies the supported platforms for this level of access. PCs and MACs are included in the reference configurations as reference configurations of platforms that are capable of supporting Motif/X-Window emulations, and may provide adequate access to ECS for users with minimal to low access requirements. The inclusion of these representative platforms in the reference configurations throughout this document is not intended to imply that direct support will be provided for these platforms for access to all ECS data and services. Refer to section 2.4.3.1 and section 3 of this document and section 4.5.1.3 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001) for a more detailed discussion of the ECS Client Subsystem, supported platforms and reference configurations.

2.3 ECS System Access Classes

Six System Access Classes have been identified by ECS User/Data Modeling studies. These System Access Classes reflect access and query activities performed by ECS registered users.

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6 HyperText Transfer Protocol/HyperText Markup Language.

The six System Access Classes are specified in Table 2-1 and will be detailed separately in this section.

Table 2-1. ECS System Access Classes

System Access Classes
Traditional User System Access Class
Data Consumer System Access Class
Data Browser System Access Class
Analytical User System Access Class
Production User System Access Class
Machine-to-Machine Interface User System Access Class

The System Access Classes begin with the Traditional User System Access Class, which requires little or no technological investment - the telephone. The System Access Classes advance in both technical complexity and in advanced user access and capabilities as they go down the list. The last System Access Class, the Machine-to-Machine Interface User System Access Class, is the most technically complex and will provide the most direct, interactive and technically advanced access to all ECS capabilities. There are options within all System Access Classes to support a variety of user needs and technical resources although there are some scientific users who may fall into more than one System Access Class[7].

The System Access Classes are capable of supporting all potential ECS users, who should find one of the System Access Classes to be a cost-effective and efficient use of their internal resources and available equipment and/or funds. ECS seeks to support access by all interested users. The more advanced methods will support faster access and processing of high volumes of data on a regular basis.

It is expected that evolution will occur within the System Access Classes but it is also expected that some evolution will occur as users move upward in the System Access Class matrix. At the current time, ECS believes the technological evolution that is expected to occur can be accommodated within subclasses to the System Access Classes specified in Table 2-1. As an example: as technologies such as PPP (Point-to-Point Protocol) and high speed modems supporting compression become more affordable and efficient, users may either move upward to a higher System Access Class or elect to purchase the optional hardware/software specified to provide more advanced capabilities within the basic System Access Class. The general strengths

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7 Refer to Table 2-3.

and weaknesses of the System Access Classes will be discussed so that the best value for the user purpose may be ascertained as well as the lowest cost for type of ECS access required.

Tables 2-2 through 2-4 provide a high level view of the projected numbers of users identified in the User/Data Model and the numbers/percentages projected for each System Access Class. Table 2-2 outlines the range of the projected number of users in each System Access Category for both U.S. science and U.S. Non-Science users[8] categories. Tables 2-3 and 2-4 will present the breakdown of these projected totals into System Access Classes for U.S. Science and U.S. Non-Science user categories.

Table 2-2. Projected Number of ECS Users

User Community Category	Projected Numbers
U.S. Scientific Users	**6,100 - 11,600**
U.S. Non-Scientific Users	**70,000 - 200,000**
Federal Government	1,500 - 2,200
States	1,500 - 3,000
Commercial-End Users	100 - 200
Commercial Intermediaries	250 - 350
Education (K-12)	
Teachers	2,000 - 7,000
Students	58,000 - 174,000
Intermediaries	
Libraries	6,000 - 12,000
Education Suppliers	80 - 140

8 SDR Presentation, June 29, 1994 & Projected Use of EOSDIS (Release B) by U.S. Non-Science Communities, White Paper Working Draft, Feb. 26, 1994.

Table 2-3. Projected Number of U.S. Scientific Users by System Access Class[9]

System Access Class	Number of Users[10]	Percentage[11]
Traditional Users	90 - 170	1.5%
Data Consumers[12]	1,400 - 2,700	23%
Data Browsers	2,000 - 3,800	32.7%
Analytical Users[13]	2,800 - 5,300	45.8%
Production Users	800 - 1,500	13%
Machine-to-Machine Interface Users	430 - 810	7%

ECS has subdivided U.S. Non-Scientific Users into several sub-categories. Table 2-4 provides a breakdown of System Access Patterns within these categories. Statistics are not available for the Traditional User System Access Class, which as can be seen in Table 2-3 above, represents a very small number of projected users.

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9 SDR Presentation, June 29, 1994.

10 The Data Consumer, Data Browser, Analytical User, and Production User System Access Classes are NOT considered to be mutually exclusive. This causes both user numbers and the total percentages to exceed the total number of users and the 100% percentage point. This group of System Access Classes as a whole represent 91.5% of scientific users, totaling 5,600 - 10,600 individual users.

11 Refer to footnote above.

12 The term "Subscription" was used in the SDR presentation instead of Consumer for presentation purposes.

13 The term "Remote File Access (RFA)" was used in the SDR presentation instead of Analytical for presentation purposes.

Table 2-4. Projected Number of U.S. Non-Scientific Users by System Access Class[14]

	System Access Classes				
Non-Science Users	**Data Consumer**	**Data Browser**	**Analytical User**	**Production User**	**Machine-to-Machine Interface User**
Federal Government	53%	29.7%	13.5%	0	3.8%
States	33%	53%	14%	0	0
Commercial	0	80%	20%	0	0
Education (K-12)					
Teachers	0	90%	10%	0	0
Students	0	95%	5%	0	0
Intermediaries					
Libraries	0	95%	5%	0	0
Education Suppliers	0	75%	25%	0	0

2.4 Overview of System Access Classes

There is some variation within aspects of the System Access Classes causing overlap in platforms/specifications. There are also several consistencies in areas such as Data Formats and Toolkits across more than one System Access Class. The following provides a more detailed overview of the common or overlapping topic areas that will be covered for each System Access Class. This is presented to avoid repeating the detail for each System Access Class where this occurs.

2.4.1 Common Environment

A common environment will be provided for all users and access methods. Of particular concern to this study is the support for a common User Interface environment and communications protocols.

2.4.1.1 Common GUI

X-Windows will provide the common graphical windowing interface with Motif as the common window management environment. The desktop paradigm will be utilized as the organizing principle for Graphic User Interface (GUI) objects presented to the user. This may be accomplished by the user access of an ECS desktop with common look and feel across all types of client workstations, or the ECS client subsystem may use (i.e., link into) the desktop provided

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14 SDR Presentation, June 29, 1994 & "Projected Use of EOSDIS (Release-B) by U.S. Non-Science Communities", White Paper Working Draft, February 26, 1994.

by the platform vendor[15]. The Scientist's Workbench, which will include services as well as tools, APIs, libraries, etc., will be based on the common GUI. Refer to section 4.5.1.3 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001) for additional information.

2.4.1.1.1 CHUI

While graphical user interfaces have increasingly become the standard interface of most operating systems and are expected to become more intrinsic to the overall computing environment, ECS will provide a Character User Interface (CHUI) for users who do not have support for the common ECS GUI. VT-100 terminal emulation will be the supported standard for this interface. The CHUI is provided as a subset of the common ECS GUI. It should be noted however that many higher level access activities, such as graphically browsing data, cannot be supported by a CHUI, which is limited to non-graphical, text-based displays and queries. Section 4.5.1.3.2.4 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001) outlines a preliminary list of the activities envisioned to be supported by the CHUI.

2.4.1.2 Common Communications Characteristics

TCP/IP will be the common communications protocol. Ethernet, SLIP/PPP as well as high-speed FDDI and ATM network environments will be supported. TCP/IP is the native communications protocol for most of the scientific community. For the non-scientific community, TCP/IP is increasingly becoming the default information highway protocol. The following are noted as indications of this trend, in government, commercial, educational, and private-home sectors:

- TCP/IP support is increasing across all platforms, i.e., Microsoft's support of TCP/IP as its default protocol and IBM's announced support of TCP/IP on the AS/400. Some analysts see TCP/IP as the leading protocol by 1996[16], overtaking Novell's IPX.
- The Federal Internetworking Requirements Panel (FIRP) Report (May 31, 1994) indicates that the federal government will no longer mandate only OSI protocols. The next version of GOSIP (GOSIP 3) will allow the use of TCP/IP as an internetworking standard. The wide availability of applications supporting this standard is expected to be attractive to many federal government installations[17].
- Providing Internet access to residents and/or school districts is being considered by many state and local government organizations, and is being implemented in several areas, e.g., the Sailor Project in Maryland, which will provide Internet access to all residents, free of charge.

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15 This decision is still pending and the corresponding issues are described in Section 4.4.1.3 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001).

16 ComputerWorld, May 23, 1994, "TCP/IP to become leading protocol," Elizabeth Horwitt.

17 Federal Computer Week, May 9, 1994, "Applications drive federal TCP/IP use."

- A wide variety of Internet access providers (supporting TCP/IP connections) are available for both commercial and private use at rates of 14.4 Kbps to T3 (45 Mbps) with several providing international service in addition to regional or national service, including the providers listed in Table 2-5. Both the numbers and variety of Internet access options are expected to increase in the near future, e.g., some providers supply or offer as a rental, a high speed modem as part of a service option.

Table 2-5. Internet Access Providers (Access Areas Supported)

AlterNet/UUNET (US & International)	NevadaNet (Nevada)
ANS (US & International)	Northwestnet (Northwestern US)
AT&T Data Communications (US & International)	Novx (Northwestern US)
BARRnet (Bay Area Regional Research Network)	NYSERnet (New York, NY)
CERFnet (Western US & International)	OARnet (Ohio)
CICnet (Midwest US - MN, WI, IA, IN, IL, MI, OH)	PACCOM (Hawaii, Australia, Japan, Korea, New Zealand, Hong Kong)
CO Supernet (Colorado)	PREPnet (Pennsylvania)
Digital Express Group (US & International)	PSCNET (Eastern US)
ICM (International)	PSI (US & International)
INet (Indiana)	SDSCnet (San Diego Area)
JVNCnet (US & International)	SprintLink (US & International)
Los Nettos (Los Angeles Area)	SURAnet (Southeastern US, South America, Puerto Rico)
MichNet/Merit (Michigan)	THEnet (Texas)
MIDnet (Midwestern States Network)	Uunorth (Canada)
MRnet (Minnesota)	VERnet (Virginia)
MSEN (Michigan)	Westnet (Western US)
NEARnet (Northeastern US)	WiscNet (Wisconsin)
NetCom (California)	World dot Net (Pacific NW)
netILLINOIS (Illinois)	WVNET (West Virginia)

There is considerable activity in commercial products that simplify Internet access and use. Implementations are available on several platforms. There are public domain versions as well as emerging commercial (COTS) versions. Many, if not most, of these tools are based on support for WWW/WAIS HTTP/HTML implementations, such as will be supported as part of the ECS information access environment, including the following examples:

- NetManage is marketing an Internet front-end to Windows, called Internet Chameleon, which supports SLIP and PPP connections over dial-up lines. A specialized version of this tool to work over PSI's Internet connections (see Table 2-5 above), will be provided over cable TV lines. The product is reported to be capable of running Mosaic.

- Spry Communications and O'Reilly & Associates are offering a product called Internet-in-a-Box, which is reported to provide everything needed to enable connection to the Internet. The product is capable of supporting Mosaic.
- Spry Communications (in addition to the product above), Quarterdeck and other vendors are releasing or about to release Internet access clients, capable of supporting access to WWW/WAIS information servers and access by Mosiac.

Continued commercialization and resulting increase in functionality and probable use of Internet-based tools, such as Mosaic, over an increasing number of platforms is expected in the immediate future.

In addition, the following On-line Services provide Internet access, along with other information services:

- America Online
- BIX (Byte Information Exchange)
- CompuServe
- Delphi
- GEnie
- Prodigy

While some of the services offered by these organizations may not be appropriate for higher levels of ECS access, it is an indication that many commercial and educational institutions will be more likely in the future to be able to support communications access and tools to participate in ECS informational searches as well as ECS registration.

2.4.2 Data Access Patterns

Many of the higher level System Access Classes, i.e., Analytical User, Production User and Machine-to-Machine Interface User System Access Classes, will utilize the same overall configurations for both access and query as well as browsing and processing, over the network with ECS data and ECS toolkits distributed electronically. The reference configurations for these users, while differing in regard to volume, frequency and duration of the specific user activity, are consistent in regard to GUI, general Operating System interfaces, Network interfaces and the software/toolkits associated with this environment. The common GUI environment would consist of a common windowing interface (X-Windows) with a common window manager (Motif). The common communications protocol will be TCP/IP, which can accommodate direct network access as well as remote dial-in access. Motif/X-Windows over TCP/IP is the native environment of most users in the scientific community.[18]

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18 Major UNIX platform vendors, with the exception of Sun Microsystems, have been standardized on OSF Motif X-Window Manager for several years. Last year Sun agreed to standardize on the Motif window manager instead of Sun's Open Look window manager, as part of the COSE agreements. This agreement

Other user classes, especially within some of the lower level system access classes, commonly use one method for access/query and another to browse or visualize the ECS data. Some of the users may access data for a commercial mainframe application. These organizations will have developed their own environment to browse and manipulate the ECS-provided data. In effect, these users will provide their own toolkits.

User of lower end devices, which will consist principally of non-scientific users, may interface the ECS environment under a Motif/X-Window emulation server mode (utilizing X-Server Software)[19] on low-end PC/MAC platforms, utilizing TCP/IP SW/HW. If direct network access is not available, the connection may need to be made with a high-speed modem. While these configurations may not be capable of supporting the entire scope of all ECS-provided capabilities that are available with higher level System Access Class configurations, it is currently expected that they will support general levels of activity desired by many users.

2.4.3 Delivery Patterns Overview

The proposed ECS user access interfaces include the capability to communicate under:

- VT-100 terminal emulation or;
- Network or Dial-up access (SLIP/PPP) under TCP/IP communications protocols and Motif/X-Windows (GUI).

Access to ECS data/services and use of the ECS toolkits under the ECS Motif/X-Windows environment requires:

- X-Windows (ECS release version).
- OSF/Motif (ECS release version).
- Desktop environment of a supported platform (refer to section 2.4.3.1)
- TCP/IP Hardware and Software (Support for SLIP/PPP and a modem capable of at least 14.4 Kbps would be required for non-network connections).

TCP/IP software is generally included with Unix OS and TCP/IP hardware is generally included with Unix workstations. For PC/MACs, TCP/IP software and hardware would be a commercially purchased add-on with most versions providing support for SLIP and/or PPP. If direct network access was not available, a high speed modem (14.4 Kbps at a minimum) would

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will standardized Motif as the common X-Window manager across the major UNIX platforms. In addition, Motif/X-Windows has been accepted as the IEEE P1295.1 (Modular Toolkit Environment) standard.

19 The supported platforms are listed in section 2.4.3.1. The X-Server software may need to be compatible with the Desktop implementation of one of these supported platforms. Consortia implementations, such as the OSF CDE, should unify many desktop implementations, but compatibility with all ECS services and toolkits as implemented on the ECS supported platforms cannot be guaranteed at this time. It is expected that at least some levels of access could be supported by this type of configuration because of the support for the common ECS GUI: Motif/X-Windows.

be needed. These speeds are the minimum supported by the ITU-TSS[20] "V.fast" standards, such as the V.32, V.32*bis*, V.34 and the V.42 compression standard. These ITU-TSS standards are supported by most Internet access providers. In addition, technical advances are expected to enhance access throughput and reliability, including:

- Work being done on the proposed IEFT SLIP and PPP protocols, enhancing reliability (error checking) and throughput (compression).
- The emergence of relatively low-cost/high speed "V.fast" modems, including the V.42 compression standard, which under ideal conditions can support up to 4 times the standard rate.
- The announced LBX (Low Bandwith X) extensions, supporting more efficient communications over serial lines in upcoming X-Windows release (X11/R6), may extend the types of activities that may be performed by users with dial-up configurations.

The continued development of technologies and products to provide and enhance Internet connection is expected to grow over the next few years. These continued advances are expected to make access to the Internet and ECS easier, more affordable and with more options to suit a variety of users and user needs.

2.4.3.1 Supported Platforms

ECS will support the native Unix Operating Systems on the following platforms:

- Sun SPARC workstations
- DEC Alpha workstations
- IBM RISC workstations
- Hewlett Packard PA RISC workstations
- Silicon Graphics workstations

Toolkits will be provided for these platforms. It is still under consideration whether support will be provided supporting the native X-Windows/Motif desktop of the respective platform or "linking" to the native desktop of the user. Provisions for providing code for recompiling on other platforms may be considered, but only the desktop environments of the platforms indicated previously will be supported and maintained. An ANSI C compiler and a cfront C^{++} Compiler for the targeted environment would be required if this option is provided. This option for unsupported platforms will not be included in the reference configurations at this time.

X-Server emulation software support on a PC/MAC platform may be contingent on the level of support and compatibility with the desktop implementation of one of the supported platforms above. Consortia implementations, such as the OSF CDE, should unify many desktop

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20 The ITU-TSS (International Telecommunications Union - Telecommunications Standards Sector) is the new organizational name for the former CCITT.

implementations, but compatibility with all ECS services and toolkits as implemented on the ECS supported platforms cannot be guaranteed at this time. It is expected that at least some levels of access could be supported by this type of configuration because of the support for the common ECS GUI: Motif/X-Windows.

2.4.4 Data Delivery Overview

The Hierarchical Data Format (HDF) from the National Center for Supercomputing Applications (NSCA) is envisioned to be the principal distribution format supported for ECS data. All ECS-provided toolkits will support this format. The ECS Scientist's Workbench, which is included as part of the ECS Toolkit, will support Import/Export (Translation) Framework Services. These services are described in section 4.5.1.3.1 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001).

Legacy file formats will also be supported within the Import/Export Framework Services. Support for the integration of other formats in the ECS Import/Export Service will be considered. The Import/Export Framework Services are flexible and evolvable services that can support integration of both DAAC-specific and scientist-specific translation utilities and routines. The APIs, Libraries, etc., supporting these capabilities will be provided as part of the ECS Toolkits, and are briefly outlined in section 2.4.5 of this document.

The support outlined in this section for ECS data delivery is consistent across all System Access Classes and will not be repeated in the more detailed discussion for each System Access Class.

2.4.4.1 Data Media Delivery Pattern Overview

ECS data may be requested or accessed by any of the System Access Classes, although certain System Access Classes, such as the Machine-to-Machine Interface User System Access Class is not expected to utilize media data in normal circumstances. Data will be provided electronically over the network for System Access Classes and users who require consistent updates or whose work is time sensitive. Some very large data sets may be required to be transmitted to the user/user organization in a media format rather than electronically.

Data may also be ordered on several types of media. The availability of ECS data on media will be attractive to users who may wish to concentrate on data of a particular type or time span and do not need continuous updates. The media types supported will include those most commonly used in computing environments. CD-ROM, 8 mm tape, and 4 mm (DAT) tape media are being strongly considered. ECS will continue to evaluate emerging media technologies, focusing especially on those that are both widely available and affordable.

Hard copy printouts of ECS data, which will include plots and graphs, will be supported on standard printers, such as ordinary laser printers. There is currently no intent to provide photographic quality prints.

2.4.5 Toolkit Overview

Toolkits, which support access to and integration with all ECS data and services, will be provided by ECS to assist science users or DAACs in building applications. The ECS Toolkits consist of software libraries and utilities that support the following:

- Software libraries implementing a well-defined Application Programming Interface (API) for ECS services.
- User interfaces to invoke the functions offered by ECS services (to the extent that they are accessible to users).
- Software libraries supporting the general ECS desktop and scientist's workbench framework.
- Applications provided by ECS as part of the scientist's workbench, e.g., for viewing and browsing ECS data and Export/Import (translation) tools, several API libraries to build science applications or prepare and manipulate data.

The applications and services provided by ECS will be sufficient for many users, especially those in the less technically advanced System Access Classes. Users who wish to develop applications and utilities using the APIs and libraries provided with the Scientist's Workbench will need access to ANSI C and C^{++} compilers, which are included as options for most System Access Classes. A more complete explanation of the services, toolkits, APIs, etc., provided by ECS is provided in section 4 of the System Design Specification for the ECS Project, 6/94 (194-207-SE1-001).

2.5 ECS System Access Classes

With the overview presented in section 2.4, Table 2-6 presents a summary of the System Access Classes identified in the ECS User/Data Model as high-level reference configurations. Each configuration supports the requirements of a range of users within each System Access Class. It should be noted that all users do not require or need the same levels of access. The summary configurations presented in the following table support the access levels identified within the System Access Classes and may not necessarily support access to all ECS data and services. Some platforms (PCs/MACs as representative emulation platforms) are mentioned in the summary Table 2-6 and the tables in sections 2.6 - 2.11 for which direct platform support by ECS is not currently planned. Although access levels sufficient for some user community needs are expected to be supported by these and similar emulation platforms for users with minimal or low access requirements, full access to all ECS capabilities will require a configuration with an ECS supported platform. ECS is currently planning direct platform support for Unix implementations on the workstations specified in section 2.4.3.1.

Table 2-6 includes specifications for the software and hardware required from commercial sources. More detailed information regarding configurations for each System Access Class is provided in sections 2.6 - 2.11. A hardware/software reference configuration and pricing are provided in section 3, which will include ECS-provided toolkits and any public domain toolkits.

Table 2-6. System Access Class Interface Requirements for ECS (1 of 2)

System Access Class	Basic User Reference Configuration[21]		Workstation Access to all ECS Services
	Access/Query Only	**Access/Query & Low Levels of Browsing**	**Access/Query & Moderate Levels of Browsing**
Traditional User	Telephone	N/A	N/A
Data Consumer	Telephone ***or*** PC/MAC with Comm. Pkg, modem (VT-100)[22]	PC/MAC[23] with: -TCP/IP HW/SW -X-Server Software -High Speed Modem (14.4/28.8 Kbps) or 10 Mbps Ethernet Card (Minimal Browsing)	Low-end Unix Workstation (32MB memory, 400MB disk) ***Optional:*** *DCE Client Software* *ANSI C Compiler* *C++ Compiler* *Media Device (CD-ROM)* *Modem, if Network Resources not available*
Data Browser	Telephone ***or*** PC/MAC with Comm. Pkg (VT-100), modem [24]	PC/MAC[25] with: -TCP/IP HW/SW -X-Server Software -High Speed Modem (14.4/28.8 Kbps) or 10 Mbps Ethernet Card (Minimal Browsing)	Low-end to low-mid-range Unix workstation (moderate browsing with Network access) ***Optional:*** *Media Device (CD-ROM/DAT)* *Modem, if Network Resources not available* *DCE Client Software* *DFS Client Software* *ANSI C Compiler* *C++ Compiler* *High Resolution Monitor (color 19" 1280 x 1024)*

21 Refer to section 2.7 for additional information on this access option for Data Consumer System Access Class users and to section 2.8 for additional information on this access option for Data Browser System Access Class users.

22 This configuration will only be able to support a subset of all ECS functionality. Refer to section 2.4.1.1.1 (CHUI).

23 This configuration may only be able to support a subset of all ECS functionality. Refer to section 2.4.3.1 (Supported Platforms).

24 This configuration will only be able to support a subset of all ECS functionality. Refer to section 2.4.1.1.1 (CHUI).

25 This configuration may only be able to support a subset of all ECS functionality. Refer to section 2.4.3.1 (Supported Platforms).

Table 2-6. System Access Class Interface Requirements for ECS (2 of 2)

System Access Class	User Reference Configuration	Workstation Access to all ECS Services
Analytical User	Workstation for all activities	Low to low-mid-range Unix workstation, (16-32MB memory, 500MB - 1GB disk space) ***Optional:*** *Media Device (CD-ROM)* *DCE Client Software* *DFS Client Software* *ANSI C Compiler* *C++ Compiler* *1 additional GB disk* *32MB Memory additional* *High-resolution monitor (color 19" or greater, approx. 1280 x 1024)* *FDDI card*
Production User	Workstation for all activities	- Mid-range to high-range Unix Workstation (Mid-range configuration with either high-end processor or memory/disk space) ***Optional:*** *Additional memory/disk space* *DCE Client Software* *DFS Client Software* *ANSI C Compiler* *C++ Compiler* *CD-ROM, DAT drives* *High-resolution monitor (color 19" or greater, approx. 1280 x 1024)* *FDDI card*
Machine-to-Machine Interface User	Workstation for all activities	High Performance RISC CPU Unix Workstation, (server-class memory and processor to support probable additional non-ECS-related high-tech equipment in addition to ECS access and processing) FDDI card ***Optional:*** *DCE Client Software* *DFS Client Software* *ANSI C Compiler* *C++ Compiler* *24-bit Graphic Accelerator Card* *Media Device (DAT)* *High-resolution monitor (color 21" approx. 1600 x 1280)* *ATM Adapter*

2.6 Traditional User System Access Class

The Traditional User System Access Class is described in the User/Data Model as accessing ECS services, including query and access through a person-to-person medium such as the telephone.

2.6.1 Data Access

At the most basic level, this class of user will not require any dedicated computer equipment since the public telephone system is viewed as the primary communication mechanism for both query and access of desired data from ECS of most users within this System Access Class.

Users in this System Access Class may also use, either instead of the telephone or in addition to the telephone, FAX services for or access or inquiries concerning orders. Standard office FAX equipment will support this type of interaction.

2.6.2 Volume of Data

Media distribution and access only are expected from this System Access Class. The volumes ordered by many users in this class will be moderate to heavy, but access/ordering is expected to be infrequent. No network connections or interface from ECS to the user environment is needed or utilized.

2.6.3 Toolkits

As indicated above, the Traditional User System Access Class requires no toolkits for the access/query steps. It is assumed that users in this category will use ECS data in an existing computing environment, often a proprietary and/or mainframe environment. Some users in this System Access Class may simply wish hard copy printout of ECS data sent to them.

2.6.4 Optional User Requirements

Any optional requirements needed will be supported within the user's computing environment.

2.7 Data Consumer System Access Class

The Data Consumer System Access Class in general differs from the Traditional User System Access Class in that the user in the Data Consumer System Access Class would use some type of terminal or computer-related devices and would probably access ECS more often and access more significant amounts of data. Members of this class would tend to access pre-processed data on standard media, usually from standing orders placed by the Data Consumer user and would not usually require browsing activities before ordering.

Table 2-7 outlines some of the modeling data obtained in "Projected Use of EOSDIS (Release B) by U.S. Non-Science Communities" that is highly applicable to this System Access Class. This table is intended as a snapshot of the primary preferences of two general user classes who have been identified as having a significant percentage of their user classes falling within the Data Consumer System Access Class. The statistics are percentages of ALL the respondents who fell into this category, that is, each percentage represents a percentage of the specific group, and does

not intend to imply a direct relationship between the data, but are presented to characterize the System Access Class[26]. Data presented at SDR on projected numbers of scientific users relevant to the System Access Class is also included in Table 2-7.

Table 2-7. User Classes Identifying Data Consumer System Access Class

General User Classes	Percentage in Data Consumer System Access Class	PC	Workstation	Electronic Access[27]
Federal Agencies	53%	27%	66%	72%
State Agencies	33%	50%	20%	50%
U.S. Scientific Users[28]	23%	N/A[29]	N/A[30]	100%

2.7.1 Data Access

Users in this varied System Access Class could be supported by any one of the following configurations, depending on the specific user requirements:

- VT-100 terminal emulation over local equipment to access the ECS character-based (CHUI) data access and query modules.
- PC/MAC with TCP/IP HW/SW and X-Server Software. A network connection would allow low to very moderate amount of browsing. Dial-up users with TCP/IP and X/Server software could not be guaranteed a minimal level of browsing with the technologies generally available currently and would be limited to character-based access and query. Advances mentioned in section 2.4.3 may improve graphical access capabilities for users with this configuration.
- Interactive Access, Browsing and Query with a low-end Unix workstation with network access.

Users in the Data Consumer System Access Class may also use the telephone for some access levels, usually in combination with one of the reference configurations above.

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26 As an example, in the first row of Table 2-7, 53% of Federal Agency users identified themselves as falling in the Data Consumer System Access Class. In the same row, 27% of the TOTAL number of Federal Agency Users (not just the 53% who identified themselves as belonging in the Data Consumer System Access Class) identified themselves utilizing PCs, 66% utilizing workstations and 72% utilizing electronic access. A more detailed breakdown within the System Access Class is not available at this time.

27 Percentages refer to access as will as delivery for non-scientific users but access only for scientific users. Tables on media type preferences are not currently available for scientific users.

28 Refer to Table 2-3. Some scientific users categorize themselves in more than one System Access Class.

29 This data is not currently available for scientific users.

30 This data is not currently available for scientific users.

2.7.2 Volume of Data

Users in this System Access Class are typically moderate volume users, with either infrequent access and/or sessions of short duration.

2.7.3 Toolkits/Services

Most users in this System Access Class would require no toolkits for basic access and query and would have an internal environment to utilize ECS data without direct interactive access to ECS. As this System Access Class is viewed in the User/Data Model, the person ordering the data may not be the person utilizing the data.

It is not expected that users in this class will utilize more than the most basic toolkits, services and applications. The Unix workstation would need to be a fully supported platform in order to fully utilize these toolkits, applications and services, as discussed in section 2.4.3.1.

2.7.4 Optional User Requirements

The following optional user requirements may be desired by some user classes within this System Access Class:

Media Device, such as CD-ROM, DAT, etc.

ANSI C Compiler

C^{++} Compiler

2.8 Data Browser

The Data Browser System Access Class and the System Access Classes following require support for graphical displays for browsing. This System Access Class is potentially the largest of the System Access Classes[31]. There are indications from the modeling studies that this System Access Class may be the most varied. The type of equipment used for access will vary from PC/MACs to low-end workstations. Table 2-8 illustrates the major uses of this System Access Class from the "Projected Use of EOSDIS (Release B) by U.S. Non-Science Communities" study for Non-Science Users and from SDR presentation data for Scientific Users. This table presents the major usages of the Data Browser System Access Class. Each statistic is self-contained across the entire group, i.e., in State Agencies, over 50% will fall into the Data Browser category, approximately 50% of all State Agency users will utilize PC/MACs for this access and 50% of all State Agency users will wish the data electronically. This table is intended as a snapshot of the primary preferences of two general user classes who have been identified as having a significant percentage of their user classes falling within the Data Browser System Access Class. The statistics are percentages of ALL the respondents who fell into this category, that is, each percentage represents a percentage of the entire group, and does not intend to imply a direct relationship between the data.

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31 Projected Use of EOSDIS (Release B) by U.S. Non-Science Communities, Working Draft, Feb. 26, 1994

Table 2-8. Data Browser System Access Class User Classes

General User Class Categories	Data Browser System Access Class Percentage	Character-Based	PC	Work Station	Electronic Access[32]
Non-Science Users:					
Federal Agencies	29.7%	0%	27%	66%	72%
State Agencies	53%	0%	50%	20%	50%
Commercial	80%	0%	20%	70%	95%
Education: Teachers	90%	15%	60%	10%	50%
Education: Students	95%	30%	50%	10%	90%
Intermediaries: Libraries	95%	20%	70%	0%	60%
Scientific Users[33]	32%	N/A[34]	N/A[35]	N/A[36]	100%

2.8.1 Data Access

Some user classes within this System Access Classes may have very infrequent access to ECS and/or have sessions with very short duration. User classes in this System Access Class will need to access ECS over a network connection, utilizing TCP/IP and Motif/X-Windows, in order to browse ECS Data.

User classes with low-end workstations and network connections, would probably choose to transfer data electronically, unless it was exceptionally large. There may also be policy limits on the size of file transfers supported in ECS. Users with PC/MACs and X-Server emulation software can potentially support some low-level browsing activities for access and query, with direct network access (refer to 2.4.3.1, Supported Platforms). Users in this System Access Class who need to do moderate amounts of browsing, will need a workstation for adequate response. If direct network access is not available, X-Server Emulation over SLIP/PPP would not support browse capabilities[37].

2.8.2 Volume of Data

Highly variable, in volume, frequency and duration.

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32 Percentages refer to access as well as delivery for non-scientific users but access only for scientific users. Tables on delivery media type preferences are not currently available for scientific users.

33 Refer to Table 2-3. Some scientific users categorize themselves in more than one System Access Class.

34 This data is not currently available for scientific users.

35 This data is not currently available for scientific users.

36 This data is not currently available for scientific users.

37 As indicated previously, advances are expected in these and related technologies, but satisfactory browse capabilities can not be assured at this time.

2.8.3 Toolkits/Services

The following commercial products would be required for this system access class: TCP/IP Software, TCP/IP HW or modem, Motif/X-Windows Software or X-Server Software supporting Motif/X-Windows. The ECS Toolkit/Services and an ECS Kerberos communications security authentication module for TCP/IP Software or DCE client implementation (commercial)[38] would also be required for full access to ECS data and services.

2.8.4 Optional User Requirements

Some users in this System Access Class may wish to include a number of optional user hardware/software items to support individual needs, such as a high resolution monitor (color 19" or greater, approx. 1280 x 1024). Other users may have unique requirements to access ECS with his or her native computing environment, such as support for FDDI needed to utilize some local environments, or a media device to support one of the ECS media types. DCE and DFS Client software may be optionally used by some users in this System Access Class. For certain types of ECS activities, DCE/DFS client software will provide enhanced levels of distributed processing options, such as transparent access to user-accessible facilities across ECS. Use of the standard ECS-provided toolkits and applications are expected by some of the more active browsers in the System Access Class while the use of ANSI C and C^{++} compilers to develop customized utilities with ECS-provided toolkits, APIs, and libraries is expected to be slight.

2.9 Analytical User

The Analytical User System Access Class supports varied classes of users, who will access, query, browse and utilize ECS data and services, but with less frequency and volume than the System Access Classes that follow. While some users in the previous System Access Classes could access ECS data and perform their desired tasks, especially if they were not intensive or frequent, on a PC/MAC under X-Server emulation, this System Access Class and those above it require a fully supported ECS workstation environment.

2.9.1 Data Access

For the Analytical User System Access Class, the access, query and browsing steps will take place utilizing the same general reference platform: an ECS-supported Unix workstation supporting direct network access and the common ECS environment (TCP/IP HW/SW and Motif/X-Windows GUI). Standard Network media (10 Mbps) Ethernet would support the user activities of this System Access Class.

Data and services will be accessed electronically. In some cases, however, it may be necessary to require that extremely large data sets only be made available on media.

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38 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

2.9.2 Volume of Data

The volume of data accessed is typically moderate, but access may frequently extend over a prolonged period. Heavy use of ECS processing facilities is expected by this System Access Class.

2.9.3 Toolkits/Services

Users in this system access class will require following commercial products: TCP/IP SW/HW, Motif/X-Windows Software. ECS Toolkit/Services and an ECS Kerberos communications security authentication module for TCP/IP Software or DCE client implementation (commercial)[39] would be utilized for access to ECS data and services.

Users in this System Access Class are expected to make heavy use of the standard utilities and applications provided with the ECS Toolkit to access ECS data and services. Heavy use of ECS Toolkits, APIs and libraries to create customized environment is also expected. Access to ANSI C Compiler and C^{++} compilers are options needed for users wishing to build customized applications or utilities with ECS-provided APIs, libraries, etc.

2.9.4 Optional User Requirements

The following optional user requirements may be desired by some user classes within this System Access Class:

High Resolution Monitors, color 19" or greater with non-interlaced resolutions approx. 1280 x 1024.

FDDI Card, where local environments require it or can optionally support it.

Media Devices, such as CD-ROM or DAT.

DCE Client Software and DFS Client Software (Commercially available from OS provider or Transarc for Sun workstations) are options that would provide increased integration and access efficiencies within the ECS environment for many users in this system access class.

ANSI C Compiler

C^{++} Compiler

Additional Disk Space/Memory

2.10 Production User

The Production User System Access Class includes mostly science users, who will be heavy users of ECS data and services. Users in this System Access Class typically have consistent and

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39 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

frequent access to ECS services and data. Some users in this class will have standing orders. These users generally need a solid workstation environment, with solid processing performance. A configuration with large amounts of memory or a high-end CPU may be needed by a substantial number of users in this class because of the amount of local processing typical of many users in this class. Standard Network access (10MB Ethernet) will support user activities at this level, although FDDI access may be available for some and even necessary on occasion for other users in this System Access Class. FDDI is included as an option for this class. For certain type of ECS activities, the optional DCE/DFS client software will provide enhanced levels of distributed processing options.

2.10.1 Data Access

Data access and queries over the network are expected to be moderate in both frequency and duration for this System Access Class.

2.10.2 Volume of Data

The volume of data accessed by this user class is expected to be moderately heavy and usually consistent in duration. Production Users are not expected to make extensive use of ECS-provided toolkits.

2.10.3 Toolkits/Services

Users in this system access class will require the following commercial products: TCP/IP Software, TCP/IP Hardware, Motif/X-Windows Software. ECS Toolkit/Services and an ECS Kerberos communications security authentication module for TCP/IP Software or DCE client implementation (commercial)[40] would be utilized for access to ECS data and services.

Users in this System Access Class are expected to make moderate use of ECS Toolkits, APIs and libraries to create customized environments. Access to ANSI C and C^{++} compilers will be required for those users who wish to develop these customized utilities and applications.

2.10.4 Optional User Requirements

The following optional user requirements may be desired by some user classes within this System Access Class:

High resolution monitor, color 19" or greater with non-interlaced resolution of approx. 1280 x 1024.

DCE Client Software and DFS Client Software (Commercially available from OS provider or Transarc for Sun) are options that would provide increased integration and access efficiencies within the ECS environment for all users in this system access class.

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40 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Media Devices, such as CD-ROM or DAT

ANSI C Compiler

C^{++} Compiler

FDDI Software/Hardware for users requiring or preferring high speed access.

2.11 Machine-to-Machine Interface User

The Machine-to-Machine Interface User System Access Class will require high speed transport (FDDI). The users often have workstations supporting high performance processors (50+ SPECmarks, including server class memory levels (80 MB or more)), disk space (2 GB) and a 19" color monitor (1280 X 1024) as standard equipment. Significant optional items such as audio and video equipment may have been added. Although the number of users in this System Access Class is expected to be very small, the use of ECS facilities is expected to be intense.

2.11.1 Data Access

Data query and access over the network are expected to be very heavy in this System Access Class, although the actual numbers of users in this System Access Class are expected to be small. Customized algorithms and high speed access characterize the users in this System Access Class. Access will be electronic, although there may be policy limits on electronic access of very large data sets. In this case data will only be available on media.

2.11.2 Volume of Data

Moderately heavy to very heavy volumes and/or with extended durations and extensive processing requirements are expected from Machine-to-Machine Interface System Access Class users. High speed access will be required for these users. Users in this System Access Class are also expected to make extensive use of the APIs and libraries provided as part of the ECS toolkits to build a substantial number of customized programs and utilities to assist in their scientific research.

2.11.3 Toolkits/Services

Users in this system access class will require the following commercial products: TCP/IP Software, TCP/IP HW, Motif/X-Windows Software. ECS Toolkit/Services and an ECS Kerberos communications security authentication module for TCP/IP Software or DCE client implementation (commercial)[41] would be utilized for access to ECS data and services. FDDI HW/SW (for high speed, high volume access) would also be required for users in this system access class.

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41 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Users in this System Access Class are expected to make very intensive use of ECS Toolkits, APIs and libraries to create customized environments. Access to ANSI C and C^{++} compilers will be required for most of these users.

2.11.4 Optional User Requirements

This System Access Class may have extensive optional requirements for some user classes, including:

DCE Client Software and DFS Client Software (Commercially available from OS provider or Transarc for Sun) are options that would provide increased integration and efficiencies within the ECS environment for all users in this System Access Class.

High Capacity Media Devices, such as 4GB DAT.

ANSI C Compiler

C^{++} Compiler

24-bit 3-D graphic accelerator, etc.

Support for ATM (Asynchronous Transfer Mode) may be desired at some period by some of these users who require the most advanced communications capabilities.

3. Reference Platforms

One or more reference configurations for each System Access Class identified in the previous section is presented in this section. As discussed previously, some System Access Classes may have users who require or may use one reference configuration for data access and query and another to browse ECS data and utilize ECS services. All identified configuration options are referenced.

Some items are marked NSP (Not Separately Priced). NSP items are items that are bundled with another product, often the operating system. Optional equipment, such as a high resolution color monitor, is listed (in italics) for each configuration. Reference configuration costs are provided for the standard reference configuration, with totals. Optional items are included for each System Access Class. Totals are not provide for these options because they may conflict with each other, e.g., a CD-ROM and DAT tape drive. Other items are upgrades or replacements for equipment on the standard configuration. Figure 3-1 provides an overview of pricing ranges of System Access Classes. A comparison of the standard configuration with a full optional implementation is provided in this figure.

3.1 Pricing Model Considerations

For consistency, the same pricing model is used for all reference configurations. Hardware is priced with a curve throughout the period (present to the year 2000). Software pricing uses a discount in the initial year, but remains level throughout the period. These differences reflect the general pricing patterns in the industry. Within this context, the pricing model is consistent for all software and hardware components. An expected price model has been used. The prices utilized are appropriate to the educational sector. Within these generalizations, some special circumstances should be noted, as outlined in the following paragraph.

3.1.1 Price Leveling at the Low End

It should be noted that in recent years, certain consumer characteristics have been identified, particularly in the lower end PC/MAC market, which has caused price leveling, i.e., the technology that is available at a certain price point increases instead of continued pricing discounts on the older technology. There appears to be a point at which the customer, who could purchase mature technology at a very low cost, prefers to purchase a machine within a certain price range with more performance or other technical features. This has tended to reduce demand for the oldest technologies, especially in the PC/MAC machine categories and this phenomena may also be in effect for low-end Unix machines. More powerful CPUs, with more memory and advanced peripherals, become available at previous year's prices. This causes the "low-end" machine to stabilize at a price point, even though the overall technology, including machine performance and features becomes greater. Corollary to this is the fact that systems, application and networking software, which continue to provide more and more features/transparency for the user, also tends to raises the "minimum" system performance level.

Some caution should be used therefore in assuming the actual availability of a PC/MAC several years into the future in the pricing range presented in the following tables. If the price leveling factor that has been apparent in recent years in low end systems continues, prices may level out for the "minimum" configuration, while the performance and features of these "minimum" configurations increase. Optional hardware peripherals associated with these platforms may also experience the same price leveling.

The reference platforms were selected to represent a general mix of pricing and configurations available for various computing purposes. There was no intent to identify either the lowest cost, the best price/performance or any other similar benchmark within the referenced configurations. The systems selected are intended to represent only a general range of price, performance and features, such as may appear in the general range of potential ECS clients considering the System Access Class characteristics identified in the User/Data Model.

3.1.2 Range of Workstation Pricing

The full range of ECS services and data will be fully accessible with the Unix workstation platforms specified in section 2.4.3.1. The specific type of work done may require a more advanced and more expensive workstation. The workstations configured with 32MB of memory and SPECmarks in the 30's and beyond will certainly be fully capable of supporting all but the most demanding user-customized environments, such as the Machine-to-Machine Interface User may require. *The workstation configurations for the extreme requirements of the Machine-to-Machine Interface User are server class configurations. These workstations are configured with server-class memory and disk space utilizing a server-class CPU processor. This type of user has technology requirements that extend beyond fully utilizing ECS services and access of ECS data and the relatively high cost of this configuration should be considered in this context.*

Multiple configurations may reflect significant configuration differences within the same System Access Class. This is intended to reflect the varying requirements of the user community represented by the System Access Class. For example, either the processor, memory or disk space may be the most important factor for the most efficient processing of user data, while average or even minimum configuration levels for other configuration components are sufficient.

3.1.3 Reference Configuration Cost Overview

Sections 3.2 through 3.7 provide costing and configuration details for two or more reference configurations for each System Access Class. Figure 3-1 is provided as an overview of the pricing ranges across all System Access Classes that require the purchase of computer-related hardware and/or software. The Traditional User System Access Class, as indicated in section 2.7, is not included in Figure 3-1 because no costs of this type are expected to be incurred by users in this class.

The range of pricing for the **Standard Configuration Ranges** (two or more) includes all standard items in the reference configuration tables, i.e., the lowest priced reference configuration would be represented by the bottom of this bar and the highest priced reference configuration is represented by the top of the bar. The **Configuration Ranges with options** includes the standard configuration with all appropriate options, i.e., the standard configurations

include an Ethernet card for a network connection, therefore a modem is not included in the option pricing and either a CD-ROM or DAT is included, although both may be mentioned as options. In the case of items which are upgrades from standard configuration item, such as a higher resolution monitor, an allowance is made for the substitution of the optional equipment.

The costs for the years 1994, 1996, 1998 and 2000 are provided for each System Access Class depicted in the table. The label under each set of bars indicates the year of the applicable pricing data. The reader is referred to precise pricing details in sections 3.3 through 3.7, as the scale of the figure supports only an overview of the general pricing ranges rather than the exact figures.

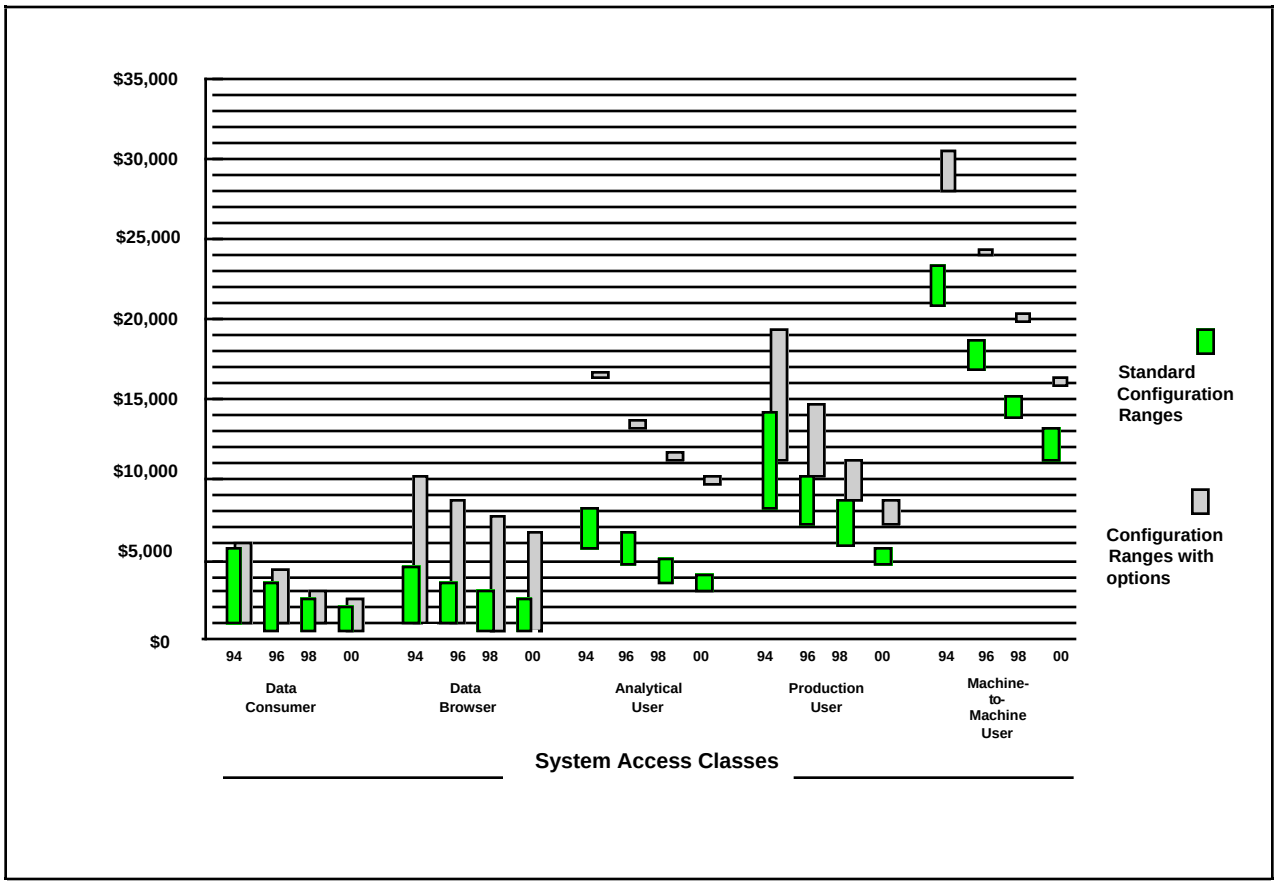

Figure 3-1. Reference Configuration Cost Ranges

3.2 Traditional User Reference Platform

Users in this System Access Class will utilize standard office equipment for access or query of ECS data. Therefore no reference platform or costs are provided. This user may turn over the data to another individual to prepare ECS data for browsing. If this is to utilize ECS data within a commercial system, i.e., a mainframe, the reference platforms and costs are out of scope of this study.

It should be noted that if browsing is eventually intended, utilizing ECS Toolkit/Services, data and services, this access will be performed by a different individual and through a different access method than that utilized by the user access or inquiring about ECS data over the telephone. The individual supporting any browsing functionality with ECS Toolkit/Services will fall into one of the higher level System Access Classes that are described in this study.

Table 3-1. Traditional User Reference Platform

Traditional User Reference Configuration				1994 Cost	1996 Cost	1998 Cost	2000 Cost
Access/Query	N/A			N/A	N/A	N/A	N/A
Browsing	N/A			N/A	N/A	N/A	N/A

3.3 Data Consumer Reference Platform

The reference platforms and costs for the Data Consumer System Access Class are provided in Table 3-2. Costs are divided into Access/Query Configurations and Browsing/Processing Configurations where appropriate, that is, when the Access/Query Configuration may be different from the Browsing/Processing Configurations. Optional configuration items are listed for specific categories of users that require specialized equipment that is not needed by all users in the System Access Class.

Table 3-2. Data Consumer Reference Platform (1 of 2)

Data Consumer Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Access/Query							
PC Clone	486 DX	8 MB	100 MB	810	656	531	430
Dial-up Modem/ VT-100 SW[42]				54	44	35	29
			Totals:	$ 864	$ 700	$ 566	$ 459
Browsing/Processing With ECS Toolkit/Services:							
Hardware	**CPU**	**Memory**	**Disk**	**1994 Cost**	**1996 Cost**	**1998 Cost**	**2000 Cost**
Vendor A: PC[43]	486 DX	8 MB	100 MB	810	656	531	430
Ethernet Card				59	48	38	32
Software:							
X-Server SW (Motif/X-Windows)				297	297	297	297
TCP/IP SW				210	210	210	210
ECS-provided Toolkit/Services				0	0	0	0
ECS provided Kerberos SW[44]				0	0	0	0
			Totals:	$ 1,376	$ 1,211	$ 1,077	$ 969

42 This configuration will only be able to support a subset of all ECS functionality. Refer to section 2.4.1.1.1 (CHUI).

43 Potential support for at least some levels of access. Refer to section 2.4.3.1.

44 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Table 3-2. Data Consumer Reference Platform (2 of 2)

Data Consumer Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Macintosh[45]	Quadra	4MB	80MB	877	710	575	466
TCP/IP				78	63	51	41
Software:							
X-Server Emulation SW				327	327	327	327
TCP/IP SW				280	280	280	280
ECS-Provided Toolset				0	0	0	0
ECS-Provided Kerberos SW[46]				0	0	0	0
			Totals:	$ 1,831	$ 1,649	$ 1,502	$ 1,383
Optional Items:							
If no network access, High Speed Modem at 14.4kbps+[47]				297	297	194	158
High Res Monitor (color, 19", 1280 x 1024)				1,025	831	673	545
CD-ROM				233	189	153	124
Hardware:	**CPU**	**Memory**	**Disk**	**1994 Cost**	**1996 Cost**	**1998 Cost**	**2000 Cost**
Vendor C: (low-end workstation w/19" color[48]	Sun SPARC-station LX	16 MB	424 MB	5,276	3,812	2,754	1,990
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows[49]				NSP	NSP	NSP	NSP
TCP/IP SW				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos SW[50]				0	0	0	0
			Totals:	$ 5,276	$ 3,812	$ 2,754	$ 1,990
Optional Items:							
DCE Client				255	255	255	255
CD-ROM				456	330	239	173

45 Potential support for at least some levels of access. Refer to section 2.4.3.1.

46 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

47 Two vendors have announced V.34 modems which support these rates. Base pricing used is one vendor's announced price.

48 SPECMarks 92: SPECfp 21.0/SPECint 26.4

49 Motif is currently priced as an add-on for Sun, however Sun will support Motif in the future and will presumably bundle it with the Operating System similar to the other major vendors. Pricing does therefore not include a separate price for Motif.

50 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

3.4 Data Browser Reference Platform

The reference platforms and costs for the Data Browser System Access Class is provided in Table 3-3. Costs are divided into Access/Query Configurations and Browsing/Processing Configurations when appropriate, that is, when the Access/Query Configuration may be different from the Browsing/Processing Configurations.

Table 3-3. Data Browser Reference Platform (1 of 3)

Data Browser Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Access/Query							
PC Clone	486 DX	8 MB	100 MB	810	656	531	430
Dial-up Modem/(VT-100) Software[51]				54	44	35	29
			Totals:	$ 864	$ 700	$ 566	$ 459
Browsing/Processing With ECS Toolkit/Services:[52]							
Hardware:	**CPU**	**Memory**	**Disk**	**1994 Cost**	**1996 Cost**	**1998 Cost**	**2000 Cost**
Vendor A: PC[53]	P5-60	8 MB	420 MB	1,671	1,354	1,097	888
Ethernet Card				59	48	38	32
Software:							
X-Server Software (Motif /X-Windows)				297	297	297	297
TCP/IP Software				210	210	210	210
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[54]				0	0	0	0
			Totals:	$ 2,237	$ 1,909	$ 1,643	$ 1,427

51 This configuration will only be able to support a subset of all ECS functionality. Refer to section 2.4.1.1.1 (CHUI).

52 Costs are provided for configurations utilizing the ECS Toolset for Browsing and Processing. Many users intending to utilize or process ECS data in existing environments may not need any additional SW/HW since the data will be provided in a variety of popular formats on several popular media types. Although some users may need some additional HW/SW, these items are not generic or consistent enough for a reference configuration costing.

53 Potential support for at least some levels of access. Refer to section 2.4.3.1.

54 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Table 3-3. Data Browser Reference Platform (2 of 3)

Data Browser Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor B: Macintosh[55]	Power PC	8MB	100MB	1,497	1,212	982	796
TCP/IP Card				78	63	51	41
Software:							
X-Server Emulation Software (Motif/X-Windows)				327	327	327	327
TCP/IP Software				270	270	270	270
ECS-Provided Toolset				0	0	0	0
ECS-Provided Kerberos Software[56]				0	0	0	0
			Totals:	$ 2,172	$ 1,872	$ 1,630	$ 1,434
Optional Items:							
If no network access, High Speed Modem at (14.4/28.8Kbps[57])				297	297	194	158
High Res Monitor (color, 19", 1280 x 1024)				1,025	831	673	545
CD-ROM				233	189	153	124

55 Potential support for at least some levels of access. Refer to section 2.4.3.1.

56 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

57 Two vendors have announced V.34 modems which support these rates. Base pricing used is one vendor's announced price.

Table 3-3. Data Browser Reference Platform (3 of 3)

Data Browser Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor C (low-mid range workstation), 16" color (1280 x 1024 resolution)	DEC 3000 Model 300LX[58]	32 MB	535 MB	4,311	3,492	2,829	2,291
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[59]				0	0	0	0
			Totals:	$ 4,311	$ 3,492	$ 2,829	$ 2,291
Optional Items:							
CD-ROM				925	750	608	492
DCE Client Software for users browsing frequently within ECS				431	431	431	431
ANSI C Compiler				741	741	741	741
C++ Compiler				1,092	1,092	1,092	1,092
High Resolution Monitor - Color 19 " or >				1,079	874	708	573
4 GB 4mm DAT tape drive				1,274	1,329	836	677
FDDI Adapter (over Fiber)				1,578	1,278	1,035	839

58 SPECmarks: SPECint 45.9/SPECfp 63.6

59 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

3.5 Analytical User Reference Platform

The reference platforms and costs for the Analytical User System Access Class are provided in Table 3-4. Optional configuration items are listed for specific categories of users that require specialized equipment that is not needed by all users in the System Access Class.

Table 3-4. Analytical User Reference Platform (1 of 2)

Analytical User Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor A (low mid-range workstation - mid-to-high range processor with minimum memory and disk space) w/ 17" color monitor	IBM Power Station 25T[60]	16MB	540MB	5,637	4,566	3,698	2,995
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[61]				0	0	0	0
			Totals:	$ 5,637	$ 4,566	$ 3,698	$ 2,995

60 SPECMarks: SPECint 62/SPECfp 76 (estimated).

61 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Table 3-4. Analytical User Reference Platform (2 of 2)

Analytical User Reference Configuration	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor B: Mid-range workstation (mid-to-high-end processor with mid-range memory and disk space) w/19" monitor	DEC Alpha -OSF/1 3000/ 300[62]	32MB	1GB	7,689	6,228	5,045	4,087
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[63]				0	0	0	0
			Totals:	$ 7,689	$ 6,228	$ 5,045	$ 4,087
Optional Items:							
CD-ROM				925	750	608	492
DCE Client Software[64]				314/344	314/344	314/344	314/344
DFS Client Software[65]				?	?	?	?
ANSI C Compiler				741	741	741	741
C++ Compiler[66]				3002/ 1,092	3002/ 1,092	3002/ 1,092	3002/ 1,092
High Resolution Monitor - Color 19" (1280 x 1024)				1,079	874	708	573
High Resolution Monitor - Color 21" (1600 x 1280)				1,640	1,329	1,076	872
32MB Memory (additional)				2974	2523	2044	1656
4 GB 4mm DAT tape drive				1,274	1,329	836	677
FDDI Adapter (over Fiber)				1,578	1,278	1,035	839

62 SPECMarks: SPECint 66.2/SPECfp 91.5.

63 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

64 Vendor A/Vendor B pricing.

65 DFS client pricing is expected, but not currently available.

66 Vendor A/Vendor B pricing.

3.6 Production User Reference Platform

The reference platforms and costs for the Production User System Access Class are provided in Table 3-5. Optional configuration items are listed for specific categories of users that require specialized equipment that is not needed by all users in the System Access Class.

It should be noted that the required or optional public domain software mentioned previously as appropriate to this System Access Class is not included in the costing chart below.

Table 3-5. Production User Reference Platform (1 of 2)

Production User Reference Configuration							
Hardware:	**CPU**	**Memory**	**Disk**	**1994 Cost**	**1996 Cost**	**1998 Cost**	**2000 Cost**
Vendor A: (High mid-range workstation - high range processor with mid-range memory and disk space) 19" color monitor	SGI Indigo 2 [67]	32MB	1GB	8,367	6,777	5,489	4,446
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[68]				0	0	0	0
			Totals:	$ 8,367	$ 6,777	$ 5,489	$ 4,446

67 SPECMarks: SPECint 59/SPECfp 61

68 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Table 3-5. Production User Reference Platform (2 of 2)

Hardware:	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor B (High mid-range workstation -(mid-range processor with server-class (high-end) memory and disk space) - w/19" color monitor	Sun SPARC 10/40 [69]	80 MB	2GB	13, 984	10,103	7,300	5,274
Ethernet Card				NSP	NSP	NSP	NSP
Software:							
Motif/X-Windows [70]				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[71]				0	0	0	0
			Totals:	$13,984	$10,103	$ 7,300	$ 5,274
Optional Items:							
CD-ROM				925	750	`608	492
DCE Client Software				394/203	394/203	394/203	394/203
DFS Client Software[72]				?	?	?	?
ANSI C Compiler				691	691	691	691
C++ Compiler				720	720	720	720
High Resolution Monitor - Color 19" (1280 x 1024)				1,079	874	708	573
High Resolution Monitor - Color 21" (1600 x 1280)				1,640	1,329	1,076	872
4 GB 4mm DAT tape drive				1,274	1,329	836	677
FDDI Adapter (over Fiber)				1,578	1,278	1,035	839

69 SPECmarks: SPECint 36/SPECfp 72

70 Motif is currently priced as an add-on for Sun, however Sun will support Motif in the future and will presumably bundle it with the Operating System similar to the other major vendors. Pricing does therefore not include a separate price for Motif.

71 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

72 DFS client pricing is expected, but not currently available.

3.7 Machine-to-Machine Interface User Reference Platform

The reference platforms and costs for the Machine-to-Machine Interface Users System Access Class are provided in Table 3-6. Optional configuration items are listed for specific categories of users that require specialized equipment that is not needed by all users in the System Access Class.

Table 3-6. Machine-to-Machine Interface User Reference Platform (1 of 2)

Machine-to-Machine Interface User Reference Configuration							
Hardware:	**CPU**	**Memory**	**Disk**	**1994 Cost**	**1996 Cost**	**1998 Cost**	**2000 Cost**
Vendor A (very high-end workstation - providing server class resources for extremely high tech single-user system)	DEC 3000/600 APX [73]	100MB	1GB	18, 977	15,371	12,451	10,085
FDDI Adapter				1,578	1,278	1,035	838
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[74]				0	0	0	0
			Totals:	$ 20,555	$ 16,649	$ 13,486	$ 10,924

73 SPECmarks: SPECint 86/SPECfp 165 (estimated).

74 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

Table 3-6. Machine-to-Machine Interface User Reference Platform (2 of 2)

Hardware:	CPU	Memory	Disk	1994 Cost	1996 Cost	1998 Cost	2000 Cost
Vendor B (very high-end workstation - providing server class resources for extremely high tech single-user system)	HP 735[75]	80MB	2GB	21,467	17,388	14,084	11,408
FDDI Adapter				1,616	1,309	1,060	859
Software:							
Motif/X-Windows				NSP	NSP	NSP	NSP
TCP/IP Software				NSP	NSP	NSP	NSP
ECS-Provided Toolkit/Services				0	0	0	0
ECS-Provided Kerberos Software[76]							
			Totals:	$ 23,083	$ 18,697	$ 15,144	$ 12,267
Optional Items:							
DCE Client Software				344/317	344/317	344/317	344/317
DFS Client Software[77]				?	?	?	?
ANSI C Compiler				945	945	945	945
C++ Compiler				1267	1267	1267	1267
CD-ROM				800	648	525	426
High Resolution Monitor - Color 21" (1600 x 1280)				1,640	1,329	1,076	872
24-bit Graphics Accelerator card				2,048	1,659	1,344	1,089
DAT tape drive				1,701	1,378	1,116	904
ATM Adapter[78] *(over copper)*				1,300	1,300	1,170	1,053

75 SPECMarks: SPECint 80/SPECfp 150.

76 A Kerberos-based security authentication product will be utilized by ECS registered users, implementing certain activity levels. The specific implementation and policy details are under consideration and may be affected by licensing and other considerations.

77 DFS client pricing is expected, but not currently available.

78 Some vendors have begun to discount these devices very recently. Unlike other hardware in this study, further dramatic discounts are not expected until 1997 for this emerging technology.

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Abbreviations and Acronyms

ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
CDE	Common Desktop Environment (COSE/OSF)
COSE	Common Operating System Environment
COTS	Commercial off-the-shelf
DAT	Digital Audio Tape
DCE	Distributed Computing Environment
DFS	Distributed File System
FDDI	Fiber Distributed Data Interface
HDF	Hierarchical Data Format
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
HW	hardware
IETF	Internet Engineering Task Force
ITU-TSS	International Telecommunications Union - Telecommunications Standards Sector (formerly the CCITT)
LBX	Low Bandwidth X
NCSA	National Center for Supercomputing Applications
OSF	Open Software Foundation
PPP	Point-to-Point Protocol
SDR	System Design Review
SLIP	Serial Line Interface Protocol
SW	software
WAIS	Wide Area Information Server
WWW	World-Wide Web